CLAIMS

1. A method for detecting an angle of a stationary rotor of a sensorless brushless DC motor comprising a stator including a plurality of windings, said rotor including permanent magnet poles, comprising steps of:

detecting inductances of said windings while said rotor is stationary; and

detecting the angle of said stationary rotor in accordance with said detected inductances.

2. The method as set forth in claim 1, wherein said stationary rotor angle detecting step detects the angle of said stationary rotor in accordance with a respective one of said windings having a minimum value of said detected inductances.

3. The method as set forth in claim 1, wherein said inductance detecting step comprises the steps of:

supplying currents to said windings; and

detecting transient phenomena of said currents,

thus detecting said inductances in accordance with the transient phenomena of said currents.

4. A method for detecting an angle of a stationary rotor of a sensorless brushless DC motor, said DC motor comprising a stator including a star connection of a U-phase winding, a V-phase winding and a W-phase winding, said rotor including permanent magnet poles, comprising the steps of:

detecting a first inductance of said U-phase winding and said W-phase winding when a first current flows from said U-phase winding to said W-phase winding when said rotor is stationary;

detecting a second inductance of said V-phase winding and said W-phase winding when a second current flows

from said V-phase winding to said W-phase winding when said rotor is stationary;

detecting a third inductance of said V-phase winding and said U-phase winding when a third current flows from said V-phase winding to said U-phase winding when said rotor is stationary;

detecting a fourth inductance of said W-phase winding and said U-phase winding when a fourth current flows from said W-phase winding to said U-phase winding when said rotor is stationary;

detecting a fifth inductance of said W-phase winding and said V-phase winding when a fifth current flows from said W-phase winding to said V-phase winding when said rotor is stationary;

detecting a sixth inductance of said U-phase winding and said V-phase winding when a sixth current flows from said U-phase winding to said V-phase winding when said rotor is stationary; and

detecting the angle of said stationary rotor in accordance with said first, second, third, fourth, fifth and sixth inductances.

5. The method as set forth in claim 4, wherein said stationary rotor angle detecting step comprises a step of detecting a minimum value of said first, second, third, fourth, fifth and sixth inductances, thus detecting the angle of said stationary rotor in accordance with said minimum value.

6. An apparatus for detecting an angle of a stationary rotor of a sensorless brushless DC motor comprising a stator including a plurality of windings, said rotor including permanent magnet poles, comprising:

an inductance detecting circuit for detecting inductances of said windings while said rotor is stationary; and

a stationary rotor angle detecting circuit, connected to said inductance detecting circuit, for detecting the angle of said stationary rotor in accordance with said detected inductances.

7. The apparatus as set forth in claim 6, wherein said inductance detecting circuit comprises:

a three-phase bridge circuit, connected to said windings, for supplying currents to said windings, said three-phase bridge circuit including a resistor connected in series to said windings to generate a plurality of detection voltages each corresponding to one of said inductances;

a first comparator, connected to said resistor, for comparing each of said detection voltages with a first reference voltage to generate a first timing signal when each of said detection voltages becomes higher than said first reference voltage; and

a second comparator, connected to said resistor, for comparing each of said detection voltages with a second reference voltage higher than said first reference voltage to generate a second timing signal when each of said detection voltages becomes higher than said second reference voltage,

said inductances being defined by time periods each beginning at a time when said first comparator generates said first timing signal and ending at a time when said second comparator generates said second timing signal.

8. The apparatus as set forth in claim 7, wherein said stationary rotor angle detecting circuit detects the angle of said stationary rotor in accordance with a respective one of said windings having a minimum value of said time periods.

9. The apparatus as set forth in claim 7, wherein said first and second reference voltages are determined by a power supply voltage.

10. The apparatus as set forth in claim 7, wherein said first and second reference voltages are variable independent of a power supply voltage.

11. An apparatus for detecting an angle of a stationary rotor of a sensorless brushless DC motor comprising a stator including a star connection of a U-phase winding, a V-phase winding and a W-phase winding, said rotor including permanent magnet poles, comprising:

a three-phase bridge circuit, connected to said windings, for supplying currents to said windings, said three-phase bridge circuit including a resistor connected in series to said windings to generate a detection voltage corresponding to an inductance of two of said windings;

a first comparator, connected to said resistor, for comparing said detection voltage with a first reference voltage to generate a first timing signal when said detection voltage becomes higher than said first reference voltage;

a second comparator, connected to said resistor, for comparing said detection voltage with a second reference voltage higher than said first reference voltage to generate a second timing signal when said detection voltage becomes higher than said second reference voltage, said inductance being defined by a time period beginning at a time when said first comparator generates said first timing signal; and ending at a time when said second comparator generates said second timing signal; and

a stationary rotor angle detecting circuit, connected to said first and second comparators, for detecting a first inductance of said U-phase winding and said W-phase winding when a first current flows from said U-phase winding to said W-phase winding when said rotor is stationary, detecting a second inductance of said V-phase winding and said W-phase winding when a second current flows from said V-phase

winding to said W-phase winding when said rotor is stationary, detecting a third inductance of said V-phase winding and said U-phase winding when a third current flows from said V-phase winding to said U-phase winding when said rotor is stationary, detecting a fourth inductance of said W-phase winding and said U-phase winding when a fourth current flows from said W-phase winding to said U-phase winding when said rotor is stationary, detecting a fifth inductance of said W-phase winding and said V-phase winding when a fifth current flows from said W-phase winding to said V-phase winding when said rotor is stationary, detecting a sixth inductance of said U-phase winding and said V-phase winding when a sixth current flows from said U-phase winding to said V-phase winding when said rotor is stationary, and detecting the angle of said stationary rotor in accordance with said first, second, third, fourth, fifth and sixth inductances.

12. The apparatus as set forth in claim 11, wherein said stationary rotor angle detecting circuit detects a minimum value of said first, second, third, fourth, fifth and sixth inductances, thus detecting the angle of said stationary rotor in accordance with said minimum value.

13. The apparatus as set forth in claim 11, wherein said first and second reference voltages are determined by a power supply voltage.

14. The apparatus as set forth in claim 11, wherein said first and second reference voltages are variable independent of a power supply voltage.

15. A method for starting a sensorless brushless DC motor comprising a stator including a plurality of windings and a rotor including permanent magnet poles, said rotor being rotated by supplying a sequence of driving current phases to said windings, comprising steps of:

detecting inductances of said windings while

said sequence of driving current phases are supplied to said windings and said rotor is stationary;

detecting an angle of said rotor in accordance with said detected inductances, the detected angle of said rotor corresponding to a stable stop point of one of said driving current phases,

supplying a first start driving current phase to said windings, said first start driving current phase being immediately after the one of said driving current phases; and

supplying a second start driving current phase to said windings after said first driving current phase is supplied, said second start driving current phase being immediately after said first start driving current phase.

16. The method as set forth in claim 15, wherein said stationary rotor angle detecting step detects the angle of said rotor in accordance with a respective one of said sequence of driving currents having a minimum value of said detected inductances.

17. The method as set forth in claim 15, wherein said inductance detecting step detects said inductances in accordance with a transient phenomena of said driving current phases.

18. A method for starting a sensorless brushless DC motor, comprising a stator including a star connection of a U-phase winding, a V-phase winding and a W-phase winding, and a rotor including permanent magnet poles, comprising the steps of:

detecting a first inductance of said U-phase winding and said W-phase winding when a first driving current phase flows from said U-phase winding to said W-phase winding when said rotor is stationary;

detecting a second inductance of said V-phase winding and said W-phase winding when a second driving current phase flows from said V-phase winding to said W-phase winding

when said rotor is stationary;

detecting a third inductance of said V-phase winding and said U-phase winding when a third driving current phase flows from said V-phase winding to said U-phase winding when said rotor is stationary;

detecting a fourth inductance of said W-phase winding and said U-phase winding when a fourth driving current phase flows from said W-phase winding to said U-phase winding when said rotor is stationary;

detecting a fifth inductance of said W-phase winding and said V-phase winding when a fifth driving current phase flows from said W-phase winding to said V-phase winding when said rotor is stationary;

detecting a sixth inductance of said U-phase winding and said V-phase winding when a sixth current flows from said U-phase winding to said V-phase winding when said rotor is stationary;

detecting an angle of said rotor in accordance with said first, second, third, fourth, fifth and sixth inductances, the detected angle of said rotor corresponding to a stable stop point of one of said first, second, third, fourth, fifth and sixth driving current phases;

supplying a first start driving current phase to said U-phase winding, said V-phase winding and said W-phase winding, said first start driving current phase being immediately after the one of said first, second, third, fourth, fifth and sixth driving current phases; and

supplying a second start driving current phase to said U-phase winding, said V-phase winding and said U-phase winding, after said first start driving current phase is supplied, said second start driving current phase being immediately after said first start driving phase.

19. An apparatus for starting a sensorless brushless DC

motor comprising a stator including a plurality of windings and a rotor including permanent magnet poles, said rotor being rotated by supplying a sequence of driving current phases to said windings, comprising:

an inductance detecting circuit for detecting inductances of said windings while said sequence of driving current phases are supplied to said windings and said rotor is stationary;

a stationary rotor angle detecting circuit, connected to said inductance detecting circuit, for detecting an angle of said rotor in accordance with said detected inductances, the detected angle of said rotor corresponding to a stable stop point of one of said driving current phases, supplying a first start driving current phase to said windings, said first start driving current phase being immediately after the one of said driving current phases, and supplying a second start driving current phase to said windings after said first start driving current is supplied, said second start driving current phase being immediately after said first start driving current phases.

20. The apparatus as set forth in claim 19, wherein said inductance detecting circuit comprises:

a three-phase bridge circuit, connected to said windings, for supplying said driving current phases to said windings, said three-phase bridge circuit including a resistor connected in series to said windings to generate a plurality of detection voltages each corresponding to one of said inductances;

a first comparator, connected to said resistor, for comparing each of said detection voltages with a first reference voltage to generate a first timing signal when each of said detection voltages becomes higher than said first reference voltage; and

a second comparator, connected to said resistor, for comparing each of said detection voltages with a second reference voltage higher than said first reference voltage to generate a second timing signal when each of said detection voltages becomes higher than said second reference voltage,

said inductances being defined by time periods each beginning at a time when said first comparator generates said first timing signal and ending at a time when said second comparator generates said second timing signal.

21. The apparatus as set forth in claim 20, wherein said stationary rotor angle detecting circuit detects the angle of said rotor in accordance with a respective one of said windings having a minimum value of said time periods.

22. The apparatus as set forth in claim 20, wherein said first and second reference voltages are determined by a power supply voltage.

23. The apparatus as set forth in claim 20, wherein said first and second reference voltages are variable independent of a power supply voltage.

24. An apparatus for starting a sensorless brushless DC motor comprising a stator including a star connection of a U-phase winding, a V-phase winding and a W-phase winding, and a rotor including permanent magnet poles, comprising:

a three-phase bridge circuit, connected to said windings, for supplying currents to said windings, said three-phase bridge circuit including a resistor connected in series to said windings to generate a detection voltage corresponding to an inductance of two of said windings;

a first comparator, connected to said resistor, for comparing said detection voltage with a first reference voltage to generate a first timing signal when said detection voltage becomes higher than said first reference voltage;

a second comparator, connected to said resistor, for comparing said detection voltage with a second reference voltage higher than said first reference voltage to generate a second timing signal when said detection voltage becomes higher than said second reference voltage, said inductance being defined by a time period beginning at a time when said first comparator generates said first timing signal and ending at a time when said second comparator generates said second timing signal, detecting a sixth inductance of said U-phase winding and said V-phase winding when a sixth driving current phase flows from said U-phase winding to said V-phase winding when said rotor is stationary, detecting an angle of said rotor in accordance with said first, second, third, fourth, fifth and sixth inductances, the detected angle of said rotor corresponding to a stable stop point of one of said first, second, third, fourth, fifth and sixth driving current phases; and

a stationary rotor angle detecting circuit, connected to said first and second comparators, for detecting a first inductance of said U-phase winding and said W-phase winding when a driving current phase flows from said U-phase winding to said W-phase winding when said rotor is stationary, detecting a second inductance of said V-phase winding and said W-phase winding when a second driving current phase flows from said V-phase winding to said W-phase winding when said rotor is stationary, detecting a third inductance of said V-phase winding and said U-phase winding when a third driving current phase flows from said V-phase winding to said U-phase winding when said rotor is stationary, detecting a fourth inductance of said W-phase winding and said U-phase winding when a fourth driving current phase flows from said W-phase winding to said U-phase winding when said rotor is stationary, detecting a fifth inductance of said W-phase winding and said V-phase

winding when a fifth driving current phase flows from said W-phase winding to said V-phase winding when said rotor is stationary, supplying a first start driving current phase to said U-phase winding, said V-phase winding and W-phase winding, said first start driving current phase being immediately after the one of said first, second, third, fourth, fifth and sixth driving current phases, and supplying a second start driving current phase to said U-phase winding, said V-phase winding and W-phase winding after said first start driving current phase is supplied, said second start driving current phase being immediately after said first start driving current phase.

25. The apparatus as set forth in claim 24, wherein said stationary rotor angle detecting circuit detects a minimum value of said first, second, third, fourth, fifth and sixth inductances, thus detecting the angle of said rotor in accordance with said minimum value.

26. The apparatus as set forth in claim 24, wherein said first and second reference voltages are determined by a power supply voltage.

27. The apparatus as set forth in claim 24, wherein said first and second reference voltages are variable independent of a power supply voltage.